The Current Status of Women in Physics

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http://www3.uwstout.edu/faculty/mcculloughl/presentations-and-pubs.cfm
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Overview

- Current status of women in physics
- Gender gaps in the physics classroom
- Better pedagogy = more women?

Women's Education

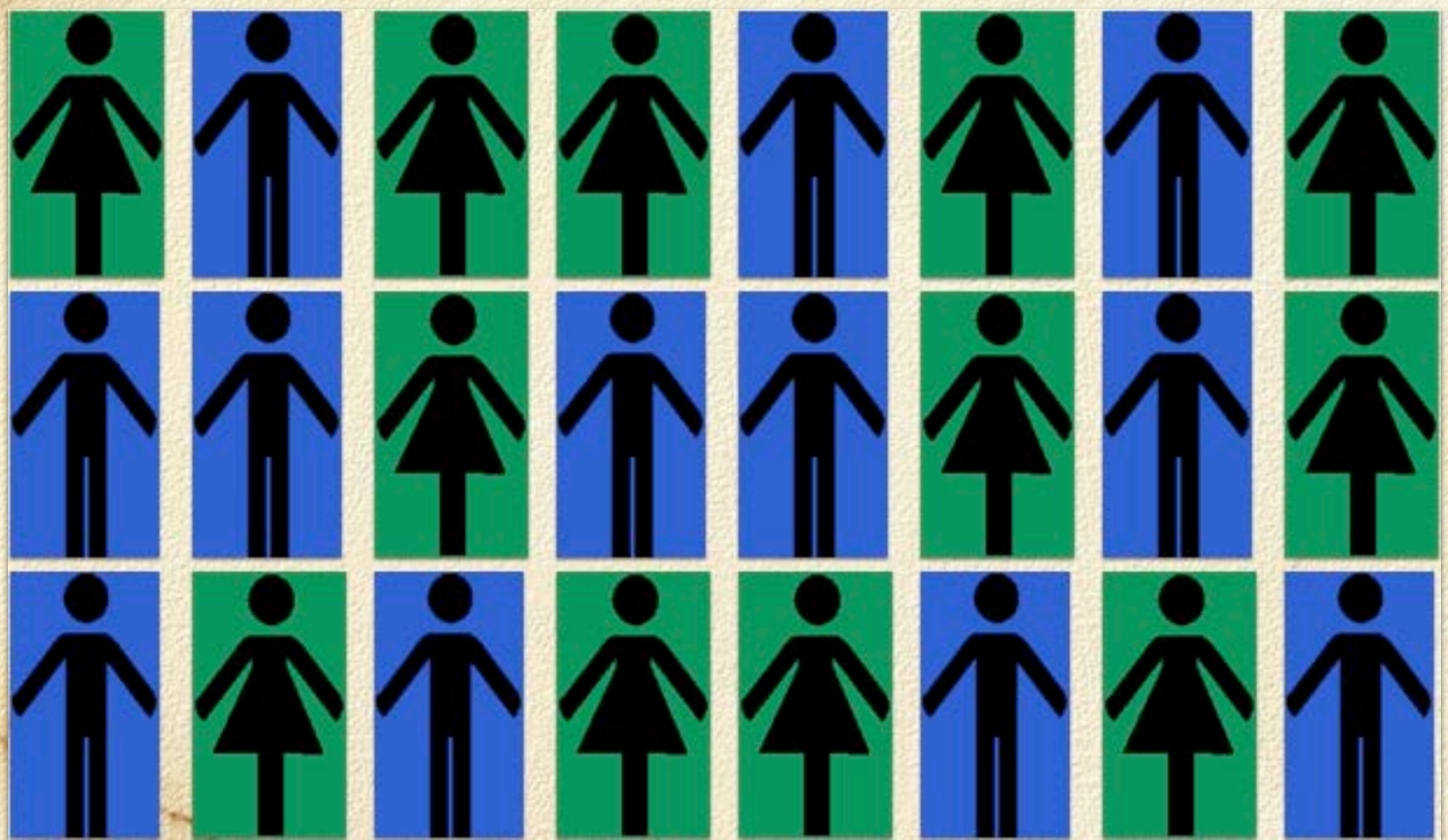
- Women make up 50.7% of the US population (2007)
- Women receive
  - about half of all high school diplomas,
  - 62% of associates degrees
  - over half of all bachelor's degrees (58%),
  - 60% of master's degrees, and
  - 51% of doctorates

Data from http://www.nsf.gov/statistics/wmpd/sex.cfm

Women in Physics

- Women earn majority of degrees
- What pattern in physics?

High School Physics

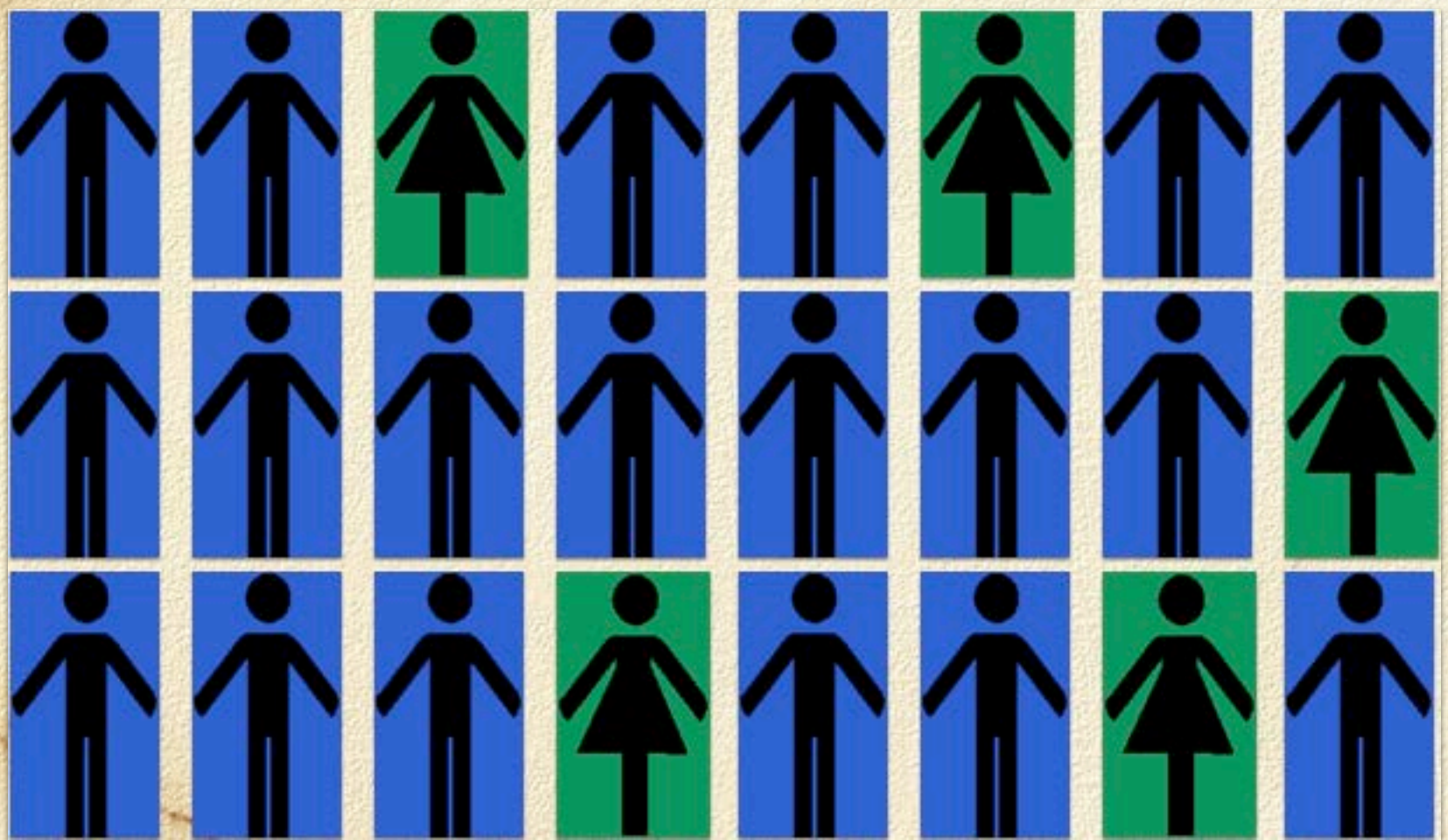


High school physics

- 2008:
  - 47% of high school physics students are women*
  - 37% of males study physics; 33% of females**
  - 4.1% of males and 2.4% of females took AP/IB physics**

*http://www.aip.org/statistics/trends/highlite/hs2/figure3.htm
**http://www.nsf.gov/statistics/seind08/c1/c1s2.htm

Undergraduate Physics

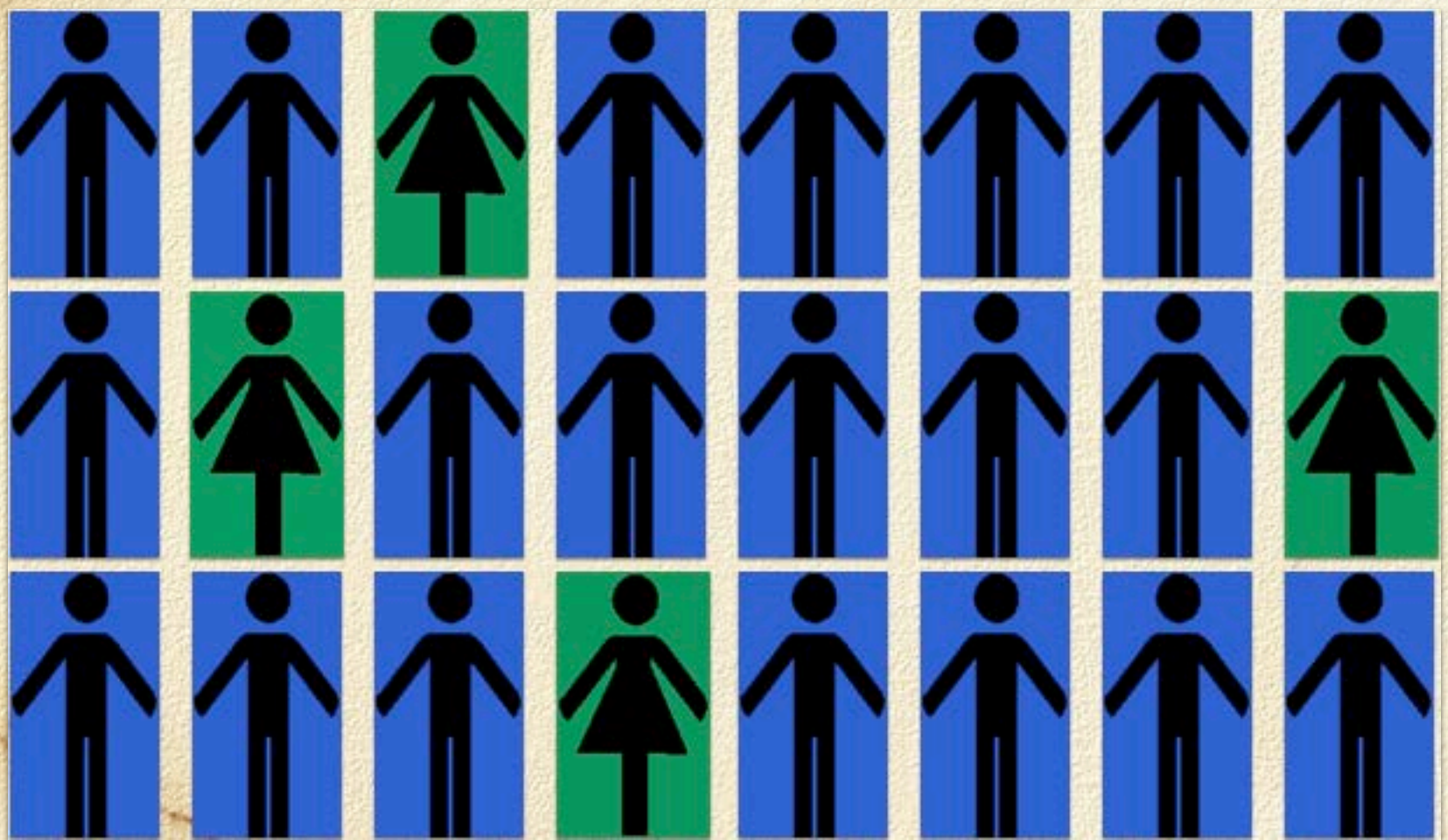


Undergraduate Physics

- Women make up ~31% of two-year college physics students*
- Among 25-year old college attendees who have had physics, 37% are female**
- Women receive 20% of physics associates degrees***
- Women receive 21% of physics bachelors degrees***

*Ivie, Rachel, and Katie Stowe. 2000. *Women in Physics, 2000*. College Park, MD: American Institute of Physics.
**Ivie, Rachel, and Kim Nies Ray. 2005. *Women in Physics, 2005*. College Park, MD: American Institute of Physics.
***Data from http://caspar.nsf.gov (NSF and NCES sources) 2007 data

Graduate Physics



Graduate Physics

- 21% of first-year graduate students are women
- Women receive 23% of master's degrees in physics
- 18% of physics doctorates go to women

http://www.nsf.gov/statistics/wmpd/sex.cfm#enroll; 2007 data

Teaching positions

- 29% of high school physics teachers are women*
- 14% of 2-yr instructors in physics are women**
- 19% of adjunct/instructors in physics are women***
- 17% of assistant professors in physics are women***
- 14% of associate professors in physics are women***
- 6% of full professors in physics are women***

*Neuschatz, Michael, and Mark McFarling. 2003. *Broadening the Base: High School Physics at the Turn of New Century*. College Park, MD: American Institute of Physics.
**http://www.aip.org/statistics/trends/highlite/tyc2001-02/table4.htm
***http://www.aip.org/statistics/trends/highlite/women3/figure1.htm

Women's Physics Education

- Lack of women in physics classes & jobs
- What's a physics educator to do?
- How do women interact with physics classes?

Gender gap in the physics classroom

- How do women fare in the physics classroom?
- In high school, girls tend to get higher grades than boys
- In high school science class, girls receive higher grades than boys

•AAUW. (1992). *How Schools Shortchange Girls.* New York: Marlowe & Co.
•AAUW (1999). *Gender Gaps.* New York: Marlowe & Co.
•Hazari, Z., Sadler, P., Tai, R. Gender differences in the high school and affective experiences of introductory college physics students. *Phys.Teach.* 46, 423-427

College grades

- Women in college tend to earn higher grades than their male counterparts
- Women's SAT/ACT scores tend to under-predict their college GPA

Mau, W-C. and Lynn, R. (2001). Gender differences on the SAT, the ACT, and college grades. *Educational Psychology* 21(2), 133-136.
Leonard, D. and Jiang, J. (1999). Gender bias and the college predictions of the SATs. *Research in Higher Education* 40(4), 375-407.

College physics grades

- Women earn lower grades than men in college physics

•McCullough, L. & Crouch, C. H. (2001) "Gender, Educational Reform, and Instructional Assessment: Part I" AAPT talk Philadelphia, PA Winter Meeting 2002

•Docktor, J., & Heller, K. (2008). Gender differences in both Force Concept Inventory and Introductory Physics Performance. Proceedings of the 2008 Physics Education Research Conference (Edmonton, Alberta, Canada)

•Tai, R. and Sadler, P. (2001). Gender differences in introductory undergraduate physics performance; university physics versus college physics in the USA. *Int'l J. of Science Education*, 23 (10), 1017-1037.

•Kost, L., Pollock, S., & Finkelstein, N. (2009) Characterizing the gender gap in introductory physics. Phys. Rev. Spec. Topics-PER 5, 010101.

College physics grades

- Women more likely to do better than men among students who had HS physics
- In university-level (calculus-based) physics, women receive lower grades than men
- Professor of same gender ➞ higher grade in college physics course

•Sadler, P. and Tai, R. (2001) Success in introductory college physics: The role of high school preparation. *Science Education*, 85(2), 111-136.

•Tai, R. and Sadler, P. (2001). Gender differences in introductory undergraduate physics performance; university physics versus college physics in the USA. *Int'l J. of Science Education*, 23(10), 1017-1037.

Conceptual testing

- Many multiple-choice conceptual tests are available for introductory physics courses; how do women fare on these tests?

FCI/FMCE

- Women average lower scores on the FCI at all class levels; this gap does not seem to be dependent on previous physics background*
- Gender gap on FMCE present with or without high school physics; gap is worse with no high school physics**

*McCullough, L. & Crouch, C. H. (2001) "Gender, Educational Reform, and Instructional Assessment: Part I" AAPT talk Philadelphia, PA Winter Meeting 2002
*Docktor, J. & Heller, K. (2008) Gender Differences in Both Force Concept Inventory and Introductory Physics Performance. Targeted Poster Session, 2008 Physics Education Research Conference (Edmonton, Canada)
**Kost, L., Pollock, S., & Finkelstein, N. (2009) Characterizing the gender gap in introductory physics. Phys. Rev. Spec. Topics-PER 5, 010101.

Test of Understanding Graphs-Kinematics

- 21 question test on kinematics graphs
- From the test author:
  - Males averaged 9.5/21 (45%)
  - Females averaged 7.2/21 (34%)
- Statistically significant gap favoring males

Beichner, R. (1994) Testing student interpretation of kinematics graphs. *Am. J. of Physics*, 62(8), 750-762.

DIRECT

- The DIRECT conceptual test on direct current circuits shows a gender difference at the university and high school levels; both differences were found to be statistically significant

	University mean score	High school mean score
Men	16	13
Women	12	11

Engelhardt, P. and Beichner, B. (2004) Students' understanding of direct current resistive electrical circuits. *Am. J. of Physics*, 72(1), 98-115.

Gender gaps exist

- Lower rates of participation of women in physics
- Conceptual tests show gap favoring males

Do interactive pedagogies help women in physics?

- Belief that IE courses are better at recruiting and retaining women
- Many, many publications recommend IE as a strategy for promoting women's participation
- What is the evidence for this?

Bad pedagogy

- "Reports of poor teaching in S.M.E. classes were by far the most common complaint of all switchers and non-switchers."
  Pedagogy was third-highest rated reason for leaving science

- Science teachers less likely to use active learning techniques; more likely to grade on curve

•Seymour, E., & Hewitt, N. (1997). *Talking about leaving: Why undergraduates leave the sciences.* Boulder, CO: Westview Press.

•Milem, J., & Astin, H. (1994). *Scientists as teachers: A look at their culture, their roles, and their pedagogy.* Paper presented at the NARST meeting, New Orleans, LA.

Good pedagogy: Harvard IE implementation

- FCI gender gap (pre, post, norm. gain)
- IE1: reduced gender gap
- IE2: reduced gap to statistical insignificance

Lorenzo, M., C. Crouch, E. Mazur, (2006) Reducing the gender gap in the physics classroom. *Am. J. of Phys.*, 74(2), 118-122.

CU-Boulder implementation

- Three stages: traditional, IE1, IE2
- IE1 and IE2 did not necessarily reduce the gender gap: no average reduction in gap
- Teacher effects?

•Pollock, S., Finkelstein, N., Kost, L. (2007). Reducing the gender gap in the physics classroom: How sufficient is interactive engagement? Phys. Rev. Spec. Topics-PER 3, 010107.
•Kost, L., Pollock, S., & Finkelstein, N. (2009). Characterizing the gender gap in introductory physics. Phys. Rev. Spec. Topics-PER 5, 010101.

U of Minnesota implementation

- Examine IE courses (differing implementation)
- No significant instructor effect on reducing gender gap
- Higher pre-test scores more likely to reduce gap (like Harvard)
- Lower pre-test scores less likely to reduce gap (like CU-Boulder)

Docktor, J., & Heller, K. (2008). Gender differences in both Force Concept Inventory and introductory physics performance. Proceedings of the 2008 Physics Education Research Conference (Edmonton, Alberta, Canada)

Avila implementation

- Workshop Physics style course with CGPS
- FMCE gender gap not reduced with IE
- FMCE <g> connect with MPEX for females?

•Anderson, E. (2003). Different attitudes and expectations toward learning physics: Insight into the gender gap in physics achievement? Presentation at the 2003 Physics Education Research Conference (Madison, Wisconsin)

•Anderson, E. (2003). Gender differences in student responses to Workshop Physics. Presentation at the 2003 Physics Education Research Conference (Madison, Wisconsin)

Rutgers program

- Extended Analytical Physics: alternative course to Analytical Physics; medium IE course
- EAP course has significantly higher pass rate for women and URM than regular AP course

Brahmia, S. White (2008). Improving learning for underrepresented groups in physics for engineering majors. Proceedings of the 2008 Physics Education Research Conference (Edmonton, Alberta, Canada)

Curricular effects

- Workshop Physics:
  Younger college women → positive experience
  More senior college women → more likely to feel negative about the interactive course structure

- SCALE-UP:
  Women were almost five times as likely to pass a SCALE-UP course than a traditional course

•Laws, P., P. Rosborough, F. Poodry, (1999). Women's responses to an activity-based introductory physics program. *Am. J. of Phys.*, 67(7), S32-S37.
•Beichner, R., J. Saul. (2003). *Introduction to the SCALE-UP Project.* Paper submitted to the Proceedings of the International School of Physics, Varenna, Italy.

Conclusions

- Women still under-represented in physics
- Gender disparities in physics classrooms
- Better pedagogy, while helping raise all students' achievement, may be particularly helpful to women; much more research needed